§11. Monitoring of Static and Varying Electromagnetic Fields Intended for a Large Plasma Experimental Facility

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Safety guidelines for various electromagnetic fields namely non-ionizing radiation has been proposed by the International Commission on Non-ionizing Radiation Protection (ICNIRP) and the other organizations. Although acute health effect has not been found it would be useful to control the environmental electromagnetic fields around a large magnetic plasma experimental facility for development of nuclear fusion. The LHD has the largest super conductive plasma confinement device with strong static magnetic field and not less magnetic field is leak out around the device. Except the static magnetic field, there are many sources of varying electromagnetic fields. Various frequencies of electromagnetic devices are applied like NBI and its electric power source of a motor generator (60Hz), heating systems of ICRF (25-100 MHz), and ECH (84-168 GHz). Also for discharge cleaning, resonance frequency (2.45 GHz) system is used. Safety issues seem to be not only strong electromagnetic field but also complex of static magnetic field and variable frequencies of magnetic fields, which are from extremely low frequency (ELF) to extremely high frequency (EHF). To examine about the safety management system in the plasma experimental facility, leakage of static magnetic field strength has been measured since the first plasma experiment of the LHD in 1998. The fixed monitoring point is 23 m far from the center of the LHD in south direction. The measurement instrument is Gauss Meter 9900 (F.W. Bell Co) and three axial probe ZOA99-3208

The leakage of magnetic field strength measured is shown in Fig. 1. Background on not-operation period is about 0.06 mT, which is a double of terrestrial magnetic field. It is increased by magnetization of steel materials in the monitoring room. When the LHD plasma magnetic field is 3 T, it increased to 0.1 -0.2 mT. As major issues of the super

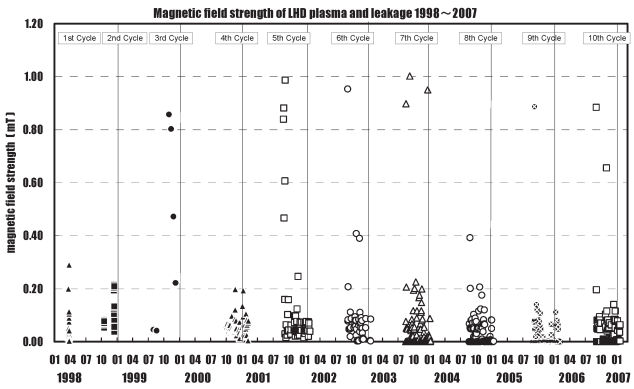

Fig. 1 Leakage of static magnetic field measured outside of the LHD hall.

conducting magnetic coil system, it decreases quickly for protection of the coil systems on quenching or on abnormal event occurrence. According to our experiences magnetic field strength at the fixed point was spontaneously increased to about 1 mT on a coil protection mode. When looking at the data in detail, small variation of less than 0.01 mT was observed according to the local island divertor (LID) operation. And reversed magnetic field was observed according to the LHD experimental condition.

Except the coil systems of LHD, there are some kinds of ELF related devices. Major devices are electric power source for super conducting magnetic coils system and a motor generator for power supply to the NBI device. The ELF electromagnetic field strength near the electric equipments was large, so entrance around such area is regulated.

There are many types of microwave generator for plasma heating such as ICRF and ECH and for discharge cleaning of plasma facing walls. We started continuous monitoring around the ICRF wave generator using a data logging system. The measurement instrument is EMC-300 and three axes electric field probe Type 18 and magnetic field probe Type 10 (Narda Co.). The photograph of the probes setting is shown in Fig.2. The data logging time is 5 Hz, 0.2 sec, and mean values of optionally selected time can be calculated. The maximum electric field observed was less than 10 V/m, although 6 minute mean value is extremely small.

Measured magnetic field was less than 0.07 A/m and usually the values were less than 0.02 A/m. All data was less than the occupational regulation level proposed as guide line by the ICNIRP. However major environmental EMF in the fusion plasma experimental facility is burst or pulse mode, so that safety management system against such not static EMF should be concerned. To investigate the safety management system, the monitoring data should be accumulated much more. We have studied in collaboration with researchers of Nagoya Institute of Technology and Utsunomiya University who are experts of EMF measurement and safety management.

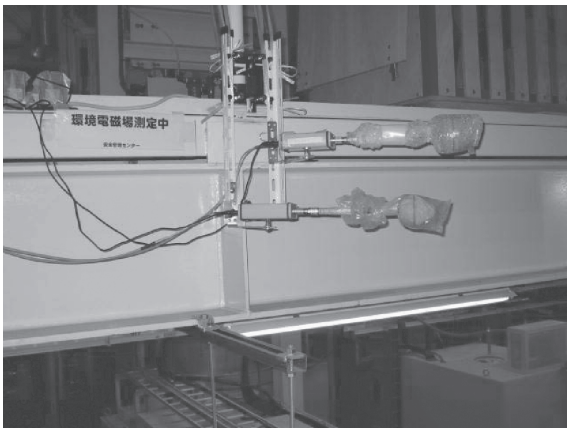

Fig. 2 Environmental electric and magnetic field strength measurement probes setting in the room of ICRF power source.